Division of Agricultural Sciences
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PRODUCTION OF MUSKMELONS IN CALIFORNIA

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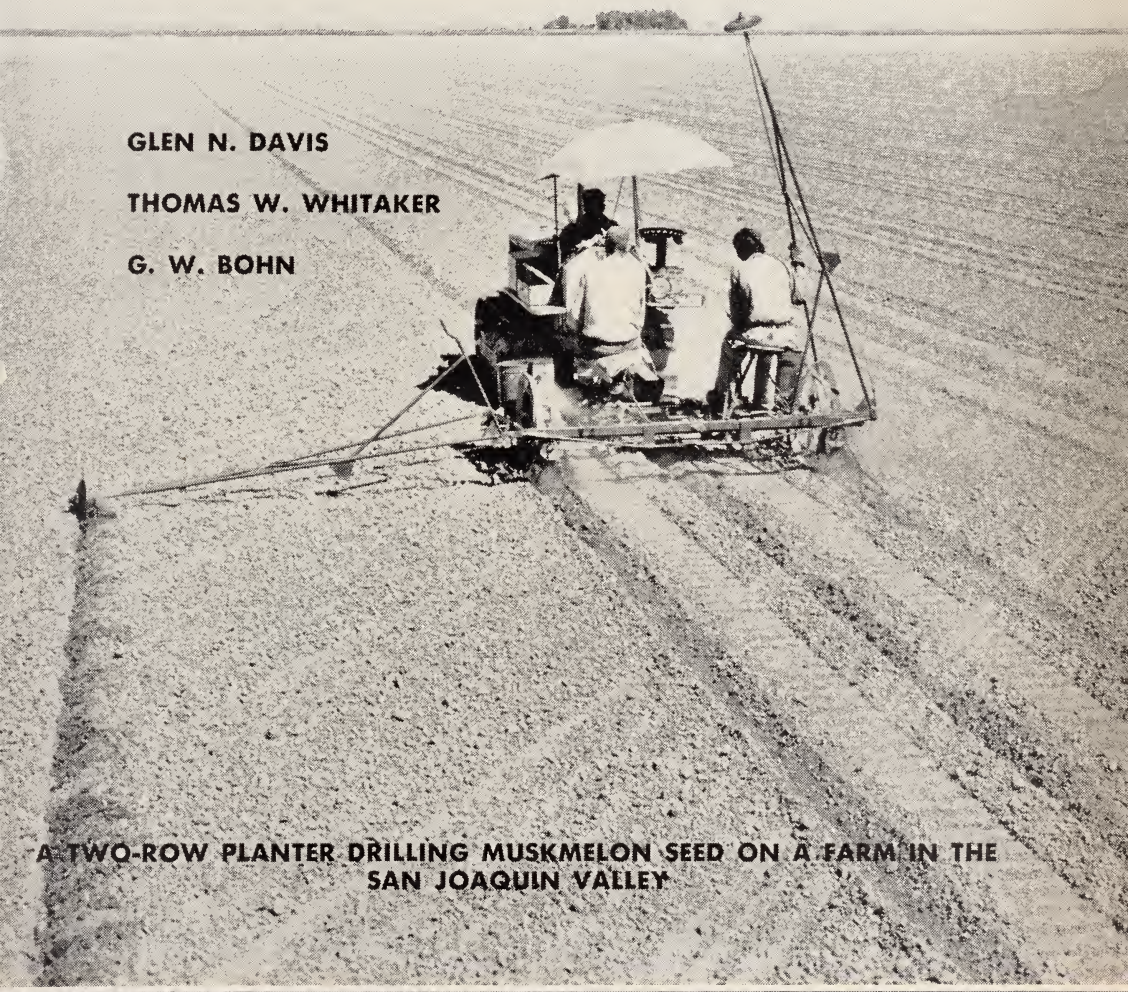

A TWO-ROW PLANTER DRILLING MUSKMELON SEED ON A FARM IN THE SAN JOAQUIN VALLEY

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PRODUCTION

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# of MUSKMELONS in CALIFORNIA

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CENTRALIZATION of the muskmelon industry in California is the result of four factors: 1) favorable environment for the production of high-quality melons; 2) development of equipment for harvesting, packaging, and transporting, and of methods insuring maintenance of quality in long-distance shipments; 3) coöperative efforts of growers to maintain quality in carlot shipments; and 4) development of adapted varieties of high quality, capable of withstanding shipment without breakdown or serious loss of quality.

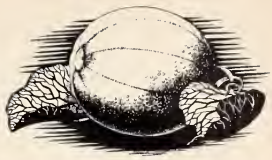
THESE FOUR FACTORS are responsible for the increase in acreage from 764 acres in 1899 to an average of almost 60,000 acres in the past five years. Such rapid expansion (see table 1) makes California the leading state in muskmelon production.

THIS CIRCULAR offers general information on the culture and handling of muskmelons, particularly for those growers who lack experience with the crop under California conditions. It supersedes Circular 352, "Growing and Handling Cantaloupes and Other Melons," by Glen N. Davis and Thomas W. Whitaker.

THE TERM "MUSKMELON" is used herein to designate the fruit and the plant of the cucurbitaceous species *Cucumis melo* Linn. The term "cantaloupe" is used to designate the small, dark-skinned, netted, salmon-fleshed muskmelons classified as *C. melo* var. *reticulatus* Naudin. The term "other melons" designates all other types of muskmelons grown in the United States, such as Honey Ball, Honey Dew, Persian, Casaba, and Crenshaw melons, which are classified as *C. melo* var. *inodorus* Naudin.

WHERE TO FIND IT

ENVIRONMENT . . . is of first concern in the production of muskmelons; it is found to be favorable only in certain areas of the state.



SOIL

Muskmelons can be grown in several types of soil, but not in muck or peat, and rarely in heavy clay or adobe. Used most extensively are sandy and sandy loam soils, found in the Turlock melon district and in parts of the Imperial Valley; and loam and clay loam soils, found in most of the Imperial Valley district.

Early or late production. Early production needs light soils—that is, soils with good drainage and open texture that warm up rapidly in the spring. Late production calls for heavier soils.

Neutral or slightly alkaline soils best. Whether the soil is light or heavy, it needs plenty of organic matter. It should be fairly fertile, well drained, and free from nematodes and parasitic fungi. It should also be free from toxic amounts of alkali. Although muskmelons are not tolerant of high concentrations of soluble salts, they thrive best on neutral or slightly alkaline soils; they are among the plants that benefit by application of lime to acid soils. Soils failing to meet these requirements may produce plants that grow poorly or that fail to retain their foliage until the crop matures. The plants may fail to produce a crop or they may produce poorly developed fruits with insufficient net and poorly colored and insipid flesh.

CLIMATE

Plenty of sunshine. Low humidity and absence of rain tend to prevent the fungus diseases that often defoliate the plants in humid sections of the state. Defoliated plants produce high proportions of cull fruits that cannot be marketed because they are too small, lack well-developed net, or have sunburned spots. The flesh of fruits from defoliated plants is often insipid. The maximum amount of sunshine on the foliage produces vigorous plants that yield high-quality fruits with firm flesh, high sugar content, and fine flavor.

Danger of frost. Muskmelon plants during all stages of development are easily killed by frost. Seedlings can be protected from injury by light frosts with paper covers; without such protection the entire growing season must be free from frost.

MUSKMELON DISTRICTS

Melons begin to reach the market in quantity during May and continue until November. The first harvests originate in the spring, or early, districts in the southern part of the state; later harvests originate in the summer, or later, districts progressively farther north.

Spring Districts

Imperial and Riverside counties. These districts include the Imperial Valley in Imperial County and the Palo Verde Valley in Riverside County. About 23,800 acres of muskmelons were grown annually in these districts during the past five years (Mullen, Stoker, and Scott, 1951).* Of this acreage about 19,000 acres were grown in Imperial County and 4,800 in Riverside County. At one time almost 75 per cent of the state acreage was localized in the Imperial Valley. Production in this district recently has been reduced, largely because of a marked increase in mosaic diseases. The Palo Verde Valley is becoming increasingly important as a district of early production, with 5,570 acres in 1949 and 3,950 acres in 1950.

* See "Literature Cited" for citations, referred to in the text by author and date.

TABLE 1—Muskmelon Production in California, 1918–1950*

Period	Acreage	Number of jumbo (70 lb) crates	Value
1918–1920	22,667	3,595,000	$ 7,870,000
1921–1925	35,886	5,151,000	11,206,000
1926–1930	50,704	7,103,000	12,187,000
1931–1935	51,008	6,342,000	7,023,000
1936–1940	38,586	5,124,000	7,500,000
1941–1945	39,612	5,362,000	17,990,000
1946–1950	58,968	7,344,000	25,663,000

* Averages are for periods indicated. The data for 1941–1950 were derived from: Mullen, J. E., W. W. Stoker, and G. A. Scott. Vegetable Crops in California. California Crop and Livestock Reporting Service, Sacramento, 1951. The earlier data were obtained from J. E. Mullen in personal correspondence.

Early yields in these districts are made possible by starting the plants during winter on the southern slopes of plant beds that are 2 to 2½ feet high. Beds at this height expose a large surface to the winter sun, thus raising the soil and air temperatures in the vicinity of the young plants. They also protect young plants from the wind and support both young and matured plants above the water level during irrigation. Additional earliness is gained by starting about half the crop under paper caps. Covered acreage is planted during November, December, and January, and harvested during late April, May, and early June. Open acreage, without paper caps, is planted during February and early March and harvested during June.

Summer Districts

South San Joaquin Valley (Tulare and Kern counties). About 4,100 acres of muskmelons are grown in the Delano district in Tulare and Kern counties and in the Wheeler Ridge district in Kern County. Most of this acreage is planted without cover on flat land from March first to April fifteenth. It is then harvested during July after the Arizona and the early California acreages have been harvested.

North San Joaquin Valley (Fresno, Merced, Stanislaus, San Joaquin, and Contra Costa counties). About 22,400 acres of muskmelons are grown in the West Side district, which extends from Helm to Los Banos in Fresno and Merced counties; in the Turlock district in Stanislaus County; and in the Manteca-Stockton-Brentwood district in San Joaquin and Contra Costa counties. Most of this acreage is planted without cover on flat land from March 15 to April 15 and harvested during late July, August, and September.

This area is particularly favorable to the production of high-quality melons of all types, including those requiring a long season. Before World War II, most of the acreage was planted to Honey Dew, Casaba, Persian, and Crenshaw melons, all of which are late-maturing. Despite competition for the cantaloupe market by other production centers within the state and by production in the east, the cantaloupe acreage has increased in the north San Joaquin Valley during the past few years.

Sacramento Valley (Yolo, Sutter, Yuba, and Butte counties). About 3,400 acres of muskmelons are grown in the Woodland-Gridley district in Yolo, Sutter, Yuba, and Butte counties. The

plantings are not concentrated in small districts, as they are in other melon areas, but are scattered over a relatively large area. A great part of the acreage is devoted to the culture of Honey Dew and Persian melons. Most of the acreage is planted without cover on flat land from April 15 to May 15 or later. It is harvested during August, September, and October.

Other districts. In addition to these districts, where most of the rail and truck shipments originate, smaller acreages are grown elsewhere in the state, primarily for local consumption. Los Angeles County grows annually about 1,700 acres of muskmelons. Small acreages are also grown in Kings, Madera, San Bernardino, and San Diego counties.

CULTURAL PRACTICES . . . include preparing the soil, planting, cultivating, forcing earliness, thinning, pruning, irrigating, and fertilizing.

PREPARING THE SOIL

Successful melon culture is dependent on careful preparation of the land, both for flat-land and raised-bed planting. The soil is worked while it is moist enough to be friable; it is never worked when so moist that it puddles. If it is too dry, it is then irrigated and left to dry until it holds only enough moisture to be thoroughly pulverized.

Flat-land preparation. Land that was in seed or covercrop the preceding season is plowed during the summer or fall to allow ample time for decay of the rough material turned under. Land previously planted to alfalfa can be successfully prepared by a shallow (6 to 8 inch) plowing followed by double-disking and a deeper (8 to 10 inch) plowing within two or three weeks. Land previously in row crops is disked and plowed as soon as the crops are harvested.

Final preparations are made about a month before planting so that the soil can settle before the seeds are planted. At this time the land is disked, harrowed, and leveled or floated. If these operations do not leave a smooth surface of well-pulverized soil, repeat one or more operation.

These operations should level the land for crops to be grown without irrigation, or should grade the land in a slope of 3 to 12 inches per 100 feet of row for irrigated crops. The slope should be steep enough to permit uniform penetration of the soil along the entire length of row without excessive amounts of tail water. In light, sandy soils steeper slopes are required than in heavier loam and clay loam soils. In a hillside field the rows should follow the contour as closely as possible to form the desired slope along the full length of each row.

Land prepared according to these directions is ready for planting crops that are to be grown on the flat land without irrigation for emergence. If the surface soil is too dry for rapid germination and emergence of the young plants, irrigation furrows are made.

Raised-bed preparation. In the early districts, where the plants are to be grown on beds, the preliminary operations are the same as those used for the flat land. About a month before planting, the flat land is made into beds, 2 to 2½ feet high and 5 to 7 feet from center to center. The beds are constructed to extend east and west to expose their southern slopes to the winter sun. Irrigation water is applied in furrows between the beds.

The beds can be laid out with a lister to which a marker is attached. The lister makes a furrow 8 to 10 inches deep, and the beds are formed by back-furrowing with a walking plow or with a two-bottom

riding plow drawn by a tractor. A large crawler-type tractor pulling six plows can be used to make two half-beds in a single operation. The south side of the bed is harrowed and smoothed with a V-drag. The bed is then ready for planting.

When late muskmelons are to be planted immediately after fall or winter lettuce in the Imperial Valley the lettuce beds are double-disked to flatten the ground. The muskmelon beds are constructed at once.

PLANTING

Row and hill spacing. In the early districts, muskmelons are usually planted in single rows on the south sides of beds spaced 5, 6, or 7 feet from center to center. The row in each bed is placed just above the irrigation water line. The hills within the row are usually spaced at 18 to 24 inch intervals, especially if covers are used to protect the young plants. If covers are not used, the hills can be spaced at 9 to 12 inch intervals. Widely spaced hills are later thinned to leave two plants to a hill; closely spaced hills are thinned to leave a single plant to each hill.

Plant spacing. Frazier (1940), in Arizona, tested Powdery Mildew Resistant Cantaloupe No. 45 for performance at 5, 8, 10, 12, 15, 20, 25, and 30 inch spacings between plants in beds 6 feet apart. Marketable yields per acre were highest and roughly equal at the 5, 8, 10, and 12 inch spacings. They were progressively lower at the wider spacings. Plants at the wider spacings matured their fruits slightly earlier, but they produced lower proportions of marketable melons because many of the fruits were sunburned. There was a possible tendency toward the production of larger fruits at the wider spacings but the differences obtained were not significant. The 9 to 12 inch spacings between single plants and the 18 to 24 inch spacings between two plant hills are recommended for the early districts until additional information is available.

In later districts, where the plants become larger and produce more fruits per plant than in the early districts, it is the custom to space the hills 4 to 5 feet apart in rows 5 to 8 feet apart. The hills are thinned to two plants to a hill so that the average spacing between individual plants in the row ranges from 2 to 2½ feet. Although Frazier's results suggest that closer spacing may be desirable, these results may not apply to muskmelons grown in the later California districts, where conditions are so different. Therefore, until additional information is available, the 2 to 2½ foot spacings between plants, or 4 and 5 foot spacings between two plant hills, are recommended for the later districts.

Amount of seed to use. A pound of cantaloupe seed of average size contains about 13,500 seeds, or enough to plant an acre at the 5×7 foot spacing between hills if 10 seeds are used to a hill. Three pounds are required for the 24 inch spacing between hills in the early districts; and four pounds, for the 18 inch spacing. Three to five pounds of seed per acre are used in power drill planters at all locations.

The number of pounds of cantaloupe seed required for each acre of cultivated land can be calculated from the equation below. Slightly more seed of the larger-seeded varieties will be required.

Depth of planting. Muskmelon seed should be planted at depths ranging from ½ to 1½ inches. The correct depth depends on the variety, on the type and condition of the soil, and on the season. Large-seeded varieties can be planted deeper than small-seeded ones. Seeds

$$\frac{43{,}560}{\text{row width} \times \text{spacing in row (feet)}} \times \begin{matrix}\text{Number}\\ \text{of seeds}\\ \text{per hill}\end{matrix} \div 13{,}500 = \begin{matrix}\text{Pounds}\\ \text{of seed}\\ \text{per acre}\end{matrix}$$

should be planted deeper in light, sandy soils and in cloddy soils than in heavy soils or well-pulverized soils. Seeds should be planted deeper late in the season, when the surface soil dries rapidly, than in winter or early spring, when the soil is cool and moist.

Methods of field planting. Muskmelon seed can be planted in the prepared land with a hoe, corn planter, or power drill. If it is to be planted with hand tools, the hills are marked with tractor tools just before planting.

With hoe-planting, a short-handled hoe is used. The soil is deeply cultivated with the hoe in a 10 to 12 inch area. A hole about 6 inches long, 4 inches wide, and about 1 inch deep is formed and the soil is flattened and firmed with the hoe. Eight or 10 seeds are scattered over this flattened surface. The seeds are covered with an inch of soil which is firmed with the hoe, then the hill is covered with a thin mulch of loose soil.

This method is relatively slow; in the early districts one man can plant about one acre in a day. However, hoe-planting permits the formation of a well-prepared seedbed at each hill; it also permits an excellent distribution of the seeds, especially where two plants are to be grown in each hill. Hoe-planting is preferable, therefore, where the hills are to be protected with paper covers.

With a corn planter, one man can plant about eight acres a day in the early muskmelon districts. This tool does not pulverize the soil where the seeds are dropped, but it can be used to advantage in fields that have been worked into good seedbed condition with power tools. If the corn planter does not have a shoe to control planting depth a shoe can be made from a piece of strap iron bent

This specially built bedding machine of three lister-like plows drawn by a 60-horsepower tractor is preparing a series of beds, each 6 feet from center to center, about 2 feet high at the apex, and smoothed with a V on one side.

to form a right angle. The depth-control shoe can be drilled for adjustment to different depths, and can be fastened with bolts to one side of the corn planter. A metal cone can be placed in the interior of the planter to improve distribution of seed in the hill.

With a power drill, one man can plant about four acres an hour in the early districts. The operator should make certain that the planter feeds regularly. Power drill planting has the advantage of placing all seed at a uniform depth and of uniformly packing the soil. It distributes the seeds evenly along the row. Hence, it is preferable for plantings where covers are not to be used. It can be used for the covered crop, also, but it is wasteful of seed. Many of the seeds and seedlings are not protected by the paper covers and are killed by frost. To distribute enough seeds under the covers to establish a perfect stand calls for the use of about 10 pounds of seed per acre.

FORCING EARLINESS

Planting location. The most important factor in early forcing is general planting location. By the same growing methods, muskmelons can be matured in the Imperial Valley four or more weeks earlier than they are harvested at locations farther north. Within a general location, some areas are usually warmer than others. This is often true of locations protected from wind by hills or by other obstructions and of southern sides of hills. Light-textured soils that warm up quickly in the spring also favor early maturity. Hence, in California the earliest melons are usually grown in sandy loam soils in favorable locations in the Imperial Valley.

Methods of planting. Maturity in the early districts is hastened by planting the seeds on the southern slopes of high beds; it is hastened still further by using paper covers to increase soil and air temperatures about the plants. The covers

The paper caps protecting these young cantaloupe plants are open at the east end.

also protect the seedlings from light frosts occurring in the southern inland valleys during the winter. The mild winter climate combined with these special methods enables the grower to plant directly in the field in the early districts during December and January, and to have vigorous plants ready to bloom when frost-free weather during early March permits removal of the covers. Protected plants mature their crops two to four weeks earlier than do unprotected plants.

Use of glassine covers. A sheet of glassine paper, 18 × 20 inches, supported by a wire or a bamboo-strip brace is generally used to cover the plant. This is placed over the hill immediately after planting. One or two inches of soil are removed from an 8 × 12 inch oval ring around the hill. A piece of 17-gauge galvanized wire 18 to 24 inches long is bent to form an arch. The ends of the wire are thrust into the ground until the wire arches about 4 inches from the ground and parallel with the row. The paper sheet is placed over the arch, and the soil is replaced in an oval ring that covers the edges of the paper. Galvanized wire and bamboo-strip braces can be used for several years, but it is necessary to use new paper each season.

Adjustment of covers for ventilation is done when the plant has one or two true leaves (at thinning). The cover is opened slightly at the east end to provide ventilation and to harden the plant. As the plant grows larger and the temperature becomes warmer, the cover is lifted higher, and the east end away from the prevailing wind is opened wider to admit more light and air. After all danger from frost has passed, about March 15 in the Imperial Valley and later in other districts, the cover is removed.

Cost of glassine-sheet covering for one acre of muskmelons varies from year to year with fluctuations in costs of materials and labor. The present cost of covering a planting at the 2 × 6 foot spacing is about $48.00, itemized as follows:

3,630 glassine sheets, 18 × 20 inches, at $5.55 per 1,000	$20.14
Contract labor at $6.00 per 1,000 hills	21.78
7,260 feet of 17-gauge galvanized wire at $10.55 per 100 pounds	5.97
Total	$47.89

Use of rigid covers. Several types of covers other than glassine sheets are available. Parchment and oiled paper are used very little because they admit less light than glassine. Rigid cones, hemispheres, and other shapes made from glassine, plastics, and other transparent materials are available. These are self-supporting and can be put in place much more rapidly than the glassine sheets.

Certain drawbacks to rigid covers have been noted. Covers observed to date have retained condensed moisture later in the day and are less easily adjusted for ventilation than are glassine sheets. Limited observations indicated that these covers do not provide as satisfactory environment for muskmelons in the Imperial Valley during winter as do glassine sheets. Plant injuries occurred more often under them. Frank Zink (Zink and Davis, 1951) observed that temperatures fluctuated more widely during night and day under rigid caps than under glassine sheets. These observations suggest that alterations in the dimensions of rigid covers, especially in relation to the soil area covered, may eventually correct these defects.

Costs of rigid covers are higher than costs of glassine sheets. Although part of the greater cost is nullified by lower labor costs and the re-use of some of the covers, cost has not been reduced enough to permit rigid covers to compete economically with glassine sheets.

Planting in greenhouse or hotbed. At some locations in mountain valleys and in the northern part of the state, late frosts are likely to be too severe for paper covers to give adequate protection in the field. At such locations the frost-free period may be too short for farmers eco-

nomically to grow crops of muskmelons from seeds planted directly in the field. Muskmelons can be grown for home consumption and for local markets at such locations if the plants are started in heated greenhouses or hotbeds (Beattie, 1935) and transplanted to the field when danger of frost has passed.

Plants are started in 3 to 5 inch pots, with a single pot used for each hill in the field. This can be done by planting six to eight seeds in each pot and thinning the plants to leave two to four plants after emergence. The seeds are sown about three to four weeks before transplanting to produce sturdy plants with three to five true leaves at transplanting. A good soil mixture can be made from 1 part composted manure, 2 parts sand, and 5 to 7 parts loam soil. If a clean soil mixture is not available, the mixture can be treated with heat or chemicals to destroy root parasites, or the seeds can be treated with fungicidal dusts (see page 31).

Suitable temperatures, adequate light and ventilation, and carefully applied irrigations will produce sturdy plants that will withstand transplanting. Day temperatures of 75° to 85° F and night temperatures of 60° to 65° are desirable. The plants should be placed so that each receives as much light as possible. Adequate spacing and prompt thinning promote sturdy, vigorous growth. Ventilation of the greenhouse or hotbed helps to provide a dry atmosphere unfavorable to parasitic diseases. Better growth will be obtained if hotbed covers are completely removed during warm days. The soil in the pots is irrigated only to prevent severe wilting. Water is applied directly to the soil without touching the plants; enough is applied to wet the soil.

Handle seedlings carefully at transplanting to prevent root damage. Muskmelons do not regenerate roots readily. The soil and root mass is knocked from the pot intact and set carefully in the field position. The hill is thinned to 2 plants when the plants are established.

CULTIVATING

Hill cultivation. When the cover is removed from covered plantings for the first thinning and adjustment for ventilating, each hill is cultivated with a short-handled hoe. After this operation the soil within the row between the hills is cultivated with a long-handled hoe.

Furrow cultivation. The furrows and the tops and north sides of the beds are cultivated with power tools. Cultivation is usually done with small tractor and two small, one-horse cultivators. The cultivator tools are adjusted to work only the top two or three inches of soil to prevent excessive damage to the fibrous roots of the plantings. Each cultivator is guided by a man who walks behind. Similar cultivation operations, in three stages, are performed as often as necessary to control weeds and maintain a soil mulch until the size of the muskmelon plants makes further cultivation impracticable.

Open-bed cultivation. Cultivation operations in open-bed plantings are similar to those used for covered plantings. Plants grown in beds are trained upward over the top of the bed and down the north side to keep them out of the irrigation furrows.

Flat-land cultivation. For flat-land plantings the soil is cultivated with tractor-drawn cultivators as soon as the plants have emerged. If the hills are carefully check-rowed or if power-drilled seeds are planted close together, the hills can be cross-cultivated. If the planting is to be irrigated, the tools on the cultivator are set to form irrigation furrows as the last cultivation is performed parallel with the irrigation slope.

Avoid plant injury. The use of power cultivators can be prolonged if vine lifters are used on the cultivator or if plants are turned over by hand. Care should be taken to prevent damage to the muskmelon plants by either method. The stems are easily damaged, and the leaf area exposed to sunlight can be reduced by careless handling. Young fruits are

often damaged if dragged over the ground and produce scarred or malformed mature melons that are not salable and are therefore a financial loss.

Weeds within the hills, and elsewhere late in the season, are removed with a hoe. About six machine cultivations and three or four hand-hoeings are commonly practiced in muskmelon growing in California.

THINNING

First thinning. Plantings sown directly in the field should be thinned in two stages. When plants in widely spaced hills have one or two true leaves between the cotyledons or seed leaves, they are thinned to about four plants to a hill. In closely spaced hills and in power drill plantings, only two plants are left to a hill. The plants that are left should be separated as far as possible within the hill. If there is danger of disturbing the roots of the remaining plants, those that are removed should be cut off rather than pulled out. The first thinning operation in covered plantings is usually performed when the covers are first adjusted for ventilation.

Second thinning. About one or two weeks after the first thinning, or perhaps a bit later in the early districts, the widely spaced plantings should be thinned again to leave two well-separated plants to a hill. The closely spaced plantings should be thinned to leave a single plant to a hill.

The thinning of muskmelon plantings started under glass and later transplanted to the field was discussed under the paragraph heading "Planting in greenhouse or hotbed."

TRAINING

Plant runners are trained away from irrigation furrows to avoid interference with irrigation and to prevent wetting and subsequent spoiling of the melons. They should be trained in a fairly compact row and cultivated in only one direction.

PRUNING

Vine-pruning. Growers often inquire about the advisability of pruning muskmelon vines to increase fruit-set or to hasten maturity. Little is gained by pinching-back or heading-back vines grown out of doors. Such pruning reduces foliage as well as numbers of fruits.

Fruit-pruning. Individual fruit-pruning to reduce the number of fruits on a vine will increase the size of those remaining. Since most varieties produce melons too large for a standard pack, fruit-pruning will be a loss rather than a benefit.

IRRIGATING

Frequency and amounts of irrigation water necessary to produce a successful crop depend on the depth and thoroughness of root development, the amount of available water the soil can hold, and the rate of water loss from the soil.

Depth of irrigation. Muskmelon roots will penetrate a deep, light-textured soil to a depth of 6 feet and will penetrate most of the top 6 feet of soil between the rows. Such soils should be wetted to a depth of 6 feet at each irrigation and the water should be applied in broad furrows or by flooding to wet as much of the soil as possible. It is vitally important when irrigating to see that water is applied very carefully. Carelessly applied water may increase the rotting of fruits by soil fungi.

Muskmelon roots may fail to penetrate shallow soils or heavy-textured soils to a depth of 6 feet. Such soils need to be wetted only to the depth penetrable by the roots. The width of the furrows should be adjusted to permit wetting as much of the soil at this depth as is practicable.

Soil's ability to hold water. Soil depth, texture, and chemical composition determine ability to hold water. Light, sandy soils usually hold the least water; clay loams and silty clay loams hold the most. Hence, sandy soils need more frequent irrigation and for shorter periods than do heavier soils.

Rate of water loss. This depends on the character of the soil, the plant cover, and climatic factors. Light-textured soils lose moisture more rapidly than heavy-textured soils. For this reason, and because of their lower water-holding capacity, they need irrigation more often than do heavier soils. Large plants take up through their roots and lose through their leaves more water than do small, young plants, and may need more frequent irrigation as the season progresses.

Temperature, moisture content of the air, and wind movements affect both the rate of water loss by plants and the rate of evaporation from the soil. For instance, high temperatures, low relative humidities, and faster air currents increase the rate of water loss from the soil. Therefore, irrigations may need to be more frequent as the season progresses, with water applied in sufficient quantity to wet all of the soil in the root zone each time. Plantings that mature during late fall may require less frequent irrigations as the weather becomes moist and cool.

Needs of early districts. Experimental data are lacking for irrigation in the early districts in southern California. The irrigation program, like that of other specialized cultural practices, has been developed by the growers. Little or no rain falls in these districts; therefore, water must be applied in preparing the land as well as in growing the crop.

Water applied to the preceding crop usually leaves the soil moist enough to be prepared for the next crop. Following these operations the field is arranged in *lands* about 50 feet wide and varying in length, with raised borders for flood irrigation. If the soil is excessively salty it is leached by flooding during the summer, with or without tile drainage.

About two months before planting, the land is irrigated and the soil is allowed to dry out enough to be worked properly for preparation into beds. After these are formed, water is run into the furrows between beds to wet the soil in the beds. The soil is then left to dry until it has a moisture content that makes it suitable for planting.

Irrigation water is applied after planting to wet the soil through and above the planting line. After emergence, water is often withheld until flowering to avoid frost injury, to maintain soil warmth, and to promote early flowering. Some growers apply water during this period, at about the time the covers are removed. Moderate amounts of water are applied after the plants have set one or two fruits and again at two- or three-week intervals until harvest. During the hot harvest period, water is applied briefly at about five-day intervals to prevent excessive cracking of the soil.

Needs of late districts. A muskmelon crop can be grown without irrigation in the northern districts if late winter rains leave the soil throughout the future root zone thoroughly wet at planting. Even under these conditions, however, yields of marketable melons are increased by the application of 6 inches or more of water before harvest (Doneen and MacGillivray, 1943).

According to experiments at Davis (Doneen and MacGillivray, 1943) 6 inches or more of water should be applied in the northern districts during the period between emergence and harvest in deep soils that were at field capacity moisture content at planting. In drier soils, additional water is applied before or immediately after planting. Water should be applied when the plants wilt during the day. Wilting in muskmelons usually occurs first in the mature leaves near the base of the plant, and these leaves may be killed if water is withheld too long. Water also is applied before the plants cease to grow vigorously. Cessation of growth is indicated by poor color and appearance of stem tips.

FERTILIZING

Kind and quantity of fertilizer needed depend largely on soil type and amounts

of available nutrients it already contains. These characters of the soil vary with its origin and past history, including its treatment under cultivation, especially irrigation (Doneen, 1950b). Most of the soils in muskmelon-producing districts in California are alluvial deposits in desert areas. Most of the virgin soils contain abundant salts, including those salts that contain potassium. Many of them are low in nitrogen and phosphorus (Jenny, Vlamis, and Martin, 1950) and in organic matter.

Humus. Early gardeners noticed vigorous growth of muskmelons in soils rich in humus (decomposed organic matter). The resulting practice of placing barnyard manure under each hill has been used in small plantings in many parts of the United States for many years. The use of barnyard and feedlot manures is considered especially desirable in the arid interior valleys of California, which are low in organic matter. Humus content of the soil can also be increased by plowing under alfalfa, clover, cowpea, soybean, sesbania, and other soil-improving crops.

Nitrogen and phosphate. In California, muskmelons often respond to applications of both nitrogen and phosphate fertilizers. Zink and Davis (1951) recommended the use of 60 pounds of nitrogen per acre in the Imperial Valley. Half the amount can be given at planting; the remainder when the runners start. Dry fertilizers, in amounts containing 60 pounds of nitrogen per acre, can be applied with a fertilizer drill, a few inches to one side of, and a few inches below the seed. Equivalent amounts of liquid fertilizers containing nitrogen can be included in the irrigation water. If nitrogenous fertilizers have been applied to the preceding crop, the muskmelons may not need additional amounts of nitrogen.

Phosphate applications are made early, preferably at or before planting. Amounts of fertilizer that deliver 60 to 120 pounds of phosphate expressed as P_2O_5 per acre are usually applied to melon acreages in the Imperial Valley. About 600 pounds of a single superphosphate (16 to 20 per cent P_2O_5), or proportionately less of the more concentrated forms, can be broadcast before bedding the soil. Phosphate fertilizers can also be banded into the beds just before planting, a few inches to one side of, and a few inches below the seed, between the seed row and the irrigation furrow.

Equivalent amounts of liquid phosphate fertilizer can be banded into the bed with special equipment, or can be given at planting or even earlier, in the irrigation water. When using liquid fertilizer, the irrigation water must be carefully controlled to obtain uniform distribution and to prevent excessive loss of fertilizer in the waste water. Phosphate fertilizer may not be needed if it has been used on the preceding crop.

Fertilizers, such as 11-48-0 or 16-20-0, that contain nitrogen and phosphorus can

FAILURE IN FRUIT-SETTING

Growers frequently ask why the early blossoms do not set fruits. Muskmelon blossoms are of two kinds. Those that appear first produce pollen only. Those that appear later bear pistils and produce fruits. This fact accounts for the failure of the first blossoms to set fruits.

The small, undeveloped fruit can be seen at the base of the pistillate, or fruit-bearing blossom before the blossom opens. Pollen must be transferred by bees or other insects to the pistils of these flowers. In most varieties the flowers that produce the fruits contain both stamens and pistils, the male and female parts of the flower. After a few fruits have set on a vine, this burden makes such a heavy demand for food and other substances in the plant that the later pistillate flowers fail to set.

be used to supply all or part of the nitrogen and phosphorus requirements.

Potash. There is no direct experimental evidence on the effects of potash applications on muskmelon soils in California. However, many of these soils contain abundant potash. Soil fertility tests with lettuce by Jenny, Vlamis, and Martin (1950) indicated that potash added to many California soils may depress growth. Therefore, the use of potash fertilizers and of complete fertilizers is not recommended without preliminary strip tests. In such tests, fertilizers containing potash are compared with those lacking potash but containing equivalent amounts of nitrogen and phosphorus.

Trace elements. There is little evidence at present regarding the need for any of the trace elements in muskmelon culture in California. The availability of these elements in the soil is often modified by cultural practices. For example, some of the trace elements may become unavailable in soils frequently given heavy applications of phosphate fertilizers. Very small quantities of these elements are needed by plants; excessive amounts are likely to cause severe plant injury. Applications of any of the trace elements should be made to only a few plants in any field. This should be done on a strictly trial basis before an entire field is treated.

HARVESTING . . . is a difficult step, because melons must be picked at exact maturity, and not all melons tend to mature at the same time.

The grower and shipper should make every effort to place a high-quality product in the retail market to maintain competition with other fruits. The preceding discussions indicated the importance of environment and cultural practices on quality. Of equal importance in the production of muskmelons are the processes of harvesting and packing.

EFFECTS OF MATURITY ON QUALITY

Muskmelons maturing on the vine without becoming over-ripe are superior in quality to those harvested immature or left on the vine after they are ripe. The sugar content, flavor, and texture of the fruit flesh improve very rapidly as the fruit approaches maturity. The sugar content does not increase after the fruit is picked. Flavor and texture improve for a few days after harvest and attain the highest quality in fruits picked when they have reached maximum sugar content. Thus, fruits harvested immature never attain these desirable characteristics.

The ripening processes continue very rapidly in fruit left on the vine too long after it has reached maximum sugar content. The fruits become soft and lose sugar during packing, shipping, and marketing; they are also subject to attack by various fungi, bacteria, and insects.

DETERMINING MATURITY

By abscission crack. Fortunately, nature has provided an excellent means of gauging the ripening process in most varieties of cantaloupes. As the fruit approaches maturity, a light abscission crack develops at the joint where the fruit is attached to the stem. When this crack completely encircles the joint, the melon is at the *full-slip* stage and contains the maximum amount of sugar. This is the time for harvesting most melons.

Full-slip melons of the western shipping varieties are superior in quality to half-slip melons (when half the stem breaks free from the fruit at slight pressure) when they are harvested and, with

present-day refrigeration, continue to be superior even after transportation to distant markets. Some varieties that are not adapted to long-distance shipping can be harvested at the full-slip stage for local markets but must be harvested earlier if they are to be shipped.

In varieties whose skin color does not change until the melons are over-ripe, the abscission process must be used and the fruits harvested according to the slip stage.

By netting and skin color. Changes in netting and skin color are other external signs of maturity. The reticulate corky layer known as the *net* becomes elevated and hard as melons approach the ripening period. Later, the skin color changes from green or gray to brown or yellow. The time of color change in relation to other ripening processes differs in the different varieties. In some varieties skin color changes coincide with abscission of the fruit from the stem. With these varieties, skin color changes are used as a measure in the harvesting and sorting of muskmelons.

By blossom-end softness. Unfortunately, the fruits of certain types of muskmelons, including Honey Ball, Honey Dew, Crenshaw, Persian, and Casaba, do not abscise or abscise only after the melons are ripe. Means other than the slip stage must be used to gauge harvest maturity in these melons, and they should be cut from the vines to prevent mechanical damage to the stem end. Slight changes in skin color, usually yellowing of part or all of the skin, are a gauge in determining maturity in these melons. In addition, the blossom end becomes slightly soft and yields to gentle pressure at maturity. Maturity is more difficult to determine in these varieties, and considerable experience is required to harvest them successfully.

FACTORS OF HARVESTING

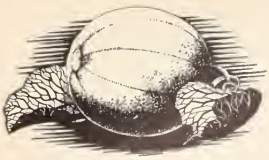
Number of harvests. Since high quality is maintained in muskmelon fruits in the field for only a brief period, it is necessary to make numerous partial harvests and to pick each fruit as it attains maximum sugar content. During peak harvest period it is common practice to go over each field every second or third day or, in extremely warm weather, every day.

Protecting fruit from heat. Excessive heating of the fruits reduces quality and increases cooling costs. Therefore, the fruits should be harvested early in the morning and protected from the sun at all times after they are picked, until they are hauled to the packing shed.

Equipment used. A citrus fruit harvesting sack is used in harvesting muskmelons. The top of the sack is held open by a wire frame and the bottom can be opened by unlatching a hook.

Picker's work. Each worker harvests the mature fruit from a single bed or row and deposits his load in a crate at the end of the row. If low-bed field wagons or pneumatic-tired trailers are used to transport the melons to the packing shed, they should be connected with the ground by a slanting plank up which the picker can walk and deposit the load gently on the floor of the wagon or trailer. If the picker drops the melon roughly on the floor of wagon or trailer the fruit will be bruised or broken.

Hauling to packing shed. The wagons or trailers used to haul muskmelons to the packing shed should be padded to prevent bruising. They should also be covered to provide shade, and if not covered should be parked in shade until they are unloaded. The trailers and wagons are unloaded directly onto conveyer belts at the packing shed by releasing a retaining board and tilting the bed of the trailer. If the bed cannot be tilted mechanically, the entire vehicle can be tilted on an inclined driveway. The angle at which the truck is tilted will control the force by which the melons are released upon the conveyer belt.



PACKING . . . includes sorting, packing, lidding, marking, and loading; inspecting determines whether melons meet state requirements.

The modern muskmelon packing shed is similar to that used for citrus and several other crops. The machinery is mobile and, with some alterations in equipment, the shed can be used for several different vegetable crops.

At the shed the melons are transported from the unloading platform along a conveyer belt past sorters to packers. The packed crates are placed on another conveyer system that transports them to the lidders, then past markers and inspectors, and finally into a railroad refrigerator car or truck at one side of the shed. New crates are transported from the crate assembly station to the packers on a second conveyer system.

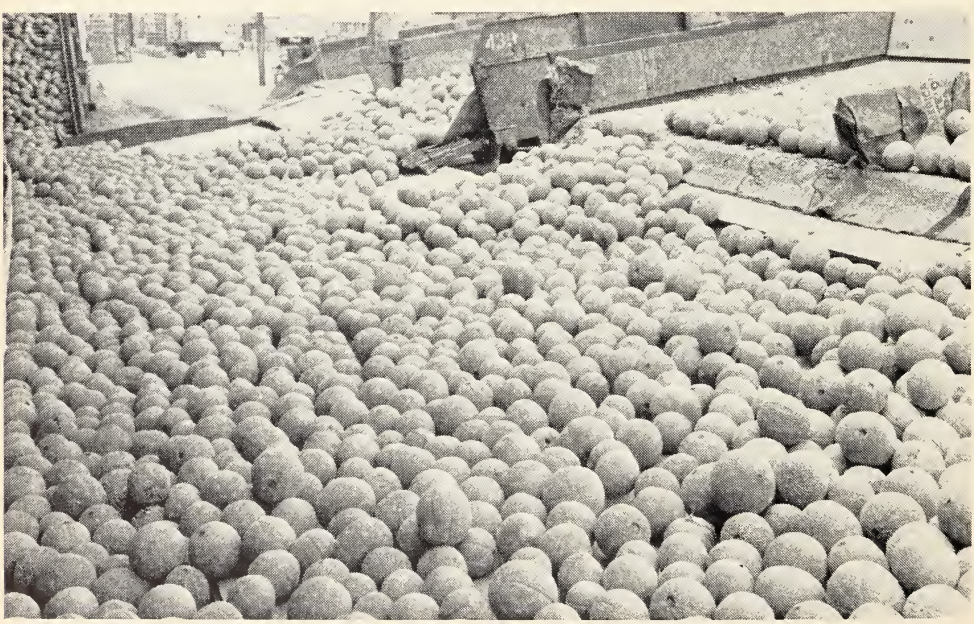
If the melons are washed or waxed, automatic washing and waxing machines equipped with brushes and rollers are placed at the desired position in the conveyer system.

Sorting. Several sorters discard cracked, bruised, decayed, immature, too small, and *slicker* fruits. Slicker fruits have poorly developed net. Other sorters grade the marketable fruits into maturity and size classes that are diverted into different channels of the conveyer system and pass to different bins along the packers' line.

Packing. The packer selects a crate of the proper dimensions (table 2) for the melons in his bin. He selects melons equal in size, and fits them firmly into the crate in three layers. He stamps his assigned number on the packed crate and places it on the conveyer system.

Lidding. The lidder adjusts the crate in the lidding machine and fastens the top shook on the crate in a single operation.

Marking. Markers tally the number of crates packed by each packer and the number of crates of different types and



At the packing shed cantaloupes are being unloaded from a trailer to a conveyer belt.

TABLE 2—Name of Container, Its Number, Inside Dimensions, and Number of Melons Contained Therein*

Name of container	Container number	Inside dimensions † (inches)	Number of melons in packed crate
Pony cantaloupe crate.....	40	11 ×11 ×22⅛	45 or 54
Standard cantaloupe crate.	39	12 ×12 ×22⅛	45 (3 tiers of 15 each) 36 (3 tiers of 12 each 27 (3 tiers of 9 each)
Jumbo cantaloupe crate...	41	13 ×13 ×22⅛	45 (3 tiers of 15 each) 36 (3 tiers of 12 each) 27 (3 tiers of 9 each)
Standard cantaloupe flat...	42	4 ×12 ×22⅛	9, 12, or 15 in 1 tier
Special cantaloupe flat....	43	4½×13⅛×22⅛	9, 12, or 15 in 1 tier
Special cantaloupe flat....	44	5 ×14 ×22⅛	8, 9, 11, or 12 in 1 tier
Honey Dew pony crate....	..	5¾×14½×22⅛	6, 8, or 12 in 1 tier
Honey Dew standard crate.	..	6¾×16 ×22⅛	6, 8, or 12 in 1 tier
Honey Dew jumbo crate..	..	7¾×16 ×22⅛	6, 8, or 12 in 1 tier
Persian crate.....	..	6¾×12 ×22⅛	6, 8, or 12 in 1 tier
Persian crate.....	..	7¾×14 ×22⅛	6, 8, or 12 in 1 tier

* The part pertaining to cantaloupes is extracted from the Agricultural Code of California. Revised to October 1, 1949. The part pertaining to Honey Dew and Persian melons extracted from Freight Container Tariff No. 1-C. Effective December 31, 1950.

† The California State Legislature on May 1, 1951, amended the code to permit the use of all melon crates now standardized by law with ¼-inch less length (reduced from 22⅛ to 21⅞ inches in inside length).

containing different numbers of melons. Other markers stamp each crate with the number of melons it contains and fasten on the company label and brand name.

Crate inspecting. Inspectors at the end of the line remove damaged crates or crates containing melons broken in the lidding machine. These crates are refinished by hand.

Loading. Loaders remove the crates from the conveyer system and arrange them in the refrigerator car or truck. The crates are held in position with wooden braces nailed into place as the loading operation proceeds.

Washing and waxing. Some shippers wash or wax muskmelon fruits to improve their appearance and to attempt to retard ripening and decay in transit. There is little evidence that either of these treatments is effective (Pentzer, Wiant, and MacGillivray, 1940). Washing may actually increase the amount of decay if diseased fruits are permitted to enter the washing machine. Even if water is not used, the brushes on cleaning machines may cause minute injuries that will permit the entrance of fungi.

Gassing. Nitrogen trichloride gas treatment controls rots less effectively than does top-icing. It has not been used since top-icing became a general practice.

Inspecting. Inspectors, controlled by the state but paid by the packer, inspect the melons to determine whether they meet the requirements of the Agricultural Code of California. The inspectors have the authority to condemn shipments that do not meet these requirements. The portions of this code applying to muskmelons are quoted below from the California Bureau of Fruit and Vegetable Standardization, Agricultural Code of California, 1949.

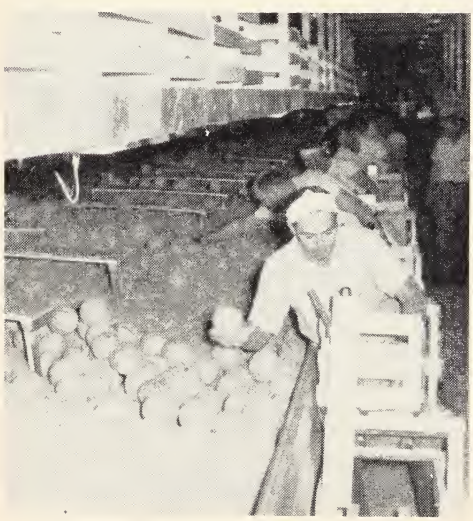
Cantaloupes shall be mature but not over-ripe, not poorly netted, and free from mold, decay, and insect injury which has penetrated or damaged the edible portion of the cantaloupe;

and free from serious damage, due to bruises, sunburn, growth cracks, cuts, sponginess, flabbiness, wilting, or other causes. Damage to any one cantaloupe is not serious unless it affects the edible portion of the individual cantaloupe.

Not more than 10 per cent, by count, of the cantaloupes in any one container or bulk lot may be below these requirements, but not to exceed one-half of this tolerance shall be allowed for any one cause.

Cantaloupes when packed shall be virtually uniform in size and there shall be the same numerical count of uniformly sized cantaloupes in each layer throughout the container.

"Mature" in the case of cantaloupes means that the appearance of the outside indicates maturity and the arils which surround the seed during the development of maturity have been absorbed and, in addition, that the juice of the edible portion shall contain not less than 8 per cent soluble solids as determined by the Balling or Brix scale hydrometer. In view of differences in climatic and other natural conditions prevailing south and east of San Gorgonio Pass, which result in the cantaloupes grown in that area having, at maturity, a higher percentage of soluble solids than the mature cantaloupes grown in the area north and west of San Gorgonio Pass, mature in the case of cantaloupes produced in the area south and east of the San Gorgonio Pass, means, in addition to the maturity requirements herein specified, that the juice of the edible portion shall contain not less than 10 per cent soluble solids, as determined by the Balling or Brix scale hydrometer or that the cantaloupes have been separated from the vine by a "full-slip" which indicates full maturity on the vine.



Workers are packing the cantaloupes in crates.

All closed containers of packed cantalopes shall bear upon them in plain sight and in plain letters on one outside end, the name of the person who first packed or authorized the packing of the cantaloupes, or the name under which such packer is engaged in business, together with a sufficiently explicit address to permit ready location of such packer. All containers of cantaloupes in which the pack does not conform to the standard pack provisions of cantaloupes in Section 829 shall be conspicuously marked in letters not less than one-half inch in height "irregular pack."

Persian melons, casabas, honeydew and honeyball melons shall be mature but not overripe, shall be free from mold, decay, and insect injury which has penetrated or damaged the edible portion of the melon; and free from serious damage, due to growth cracks, cuts, bruises, sunburn, softness, or other causes. Damage to any one of the melons mentioned herein is not serious unless it affects the edible portion of the melon.

Not more than 10 per cent, by count, of the melons in any one container or bulk lot may be below these requirements, but not to exceed one-half of this tolerance shall be allowed for any one cause.

"Mature" in the case of casabas, honeydew and honeyball melons means that the appearance from the outside indicates maturity and that the arils which surround the seeds have been absorbed; in the case of honeyball melons, that the juice of the edible portion shall contain not less than 10 per cent soluble solids as determined by the Balling or Brix scale hydrometer or that the fruit has been separated from the vine by a "full slip," which indicates actual maturity; and in the case of honeydew melons that the juice of the edible portion shall contain not less than 10 per cent soluble solids as determined by the Balling or Brix scale hydrometer or that the fruit has been separated from the vine by a "full slip," which indicates actual maturity. In view of differences in climatic and other natural conditions prevailing south and east of San Gorgonio Pass, which result in the honeydew melons grown in that area having, at maturity, a higher percentage of soluble solids than the mature honeydew melons grown in the area north and west of San Gorgonio Pass, mature in the case of honeydew melons produced in the area south and east of San Gorgonio Pass means, in addition to the maturity requirements herein specified, that the juice of the edible portion shall contain not less than 11 per cent soluble solids as determined by the Balling or Brix scale hydrometer. A "full slip" means that the fruit has separated from the stem leaving a clean, natural scar, with no

portion of the stem remaining attached, and no torn or broken skin on the fruit.

All closed containers of packed melons shall bear upon them in plain sight and in plain letters on one outside end, the name of the person who first packed or authorized the packing of the melons, or the name under which such packer is engaged in business, together with a sufficiently explicit address to permit ready location of such packer.

Soluble-solids-content requirements. These requirements were included in the code because the quality and maturity of the muskmelon fruit are closely correlated with the soluble-solids content (Chase, Church, and Denny, 1924). Fruits harvested immature and those from diseased vines have low soluble-solids content and are thereby excluded from shipments.

The hand refractometer is an accurate and convenient tool for determining the soluble-solids content in the field and in the packing shed. Samples for readings must be carefully selected because different portions of the fruit differ in soluble-solids content (Scott and MacGillivray, 1940). A fairly reliable reading can be obtained by taking a wedge of flesh midway between the rind and the seed cavity and midway between the blossom and stem ends. Readings that represent the soluble-solids content of the entire fruit more accurately can be obtained from a mixture of the juice from a longitudinal segment of the fruit or from the entire edible portion.

The hand refractometer enables an inspector to determine conveniently and rapidly whether a particular lot of muskmelons should be condemned as too low in quality for human consumption or allowed to enter wholesale and retail channels. Growers and shippers will find the hand refractometer very useful. Its proper application should enable them to check closely the condition and maturity of their melons. They could thereby maintain high quality in their products and maintain market demand for them. This practice would also materially reduce the work of the law-enforcement officials.

REFRIGERATION . . . maintaining a temperature of 35°F gives greatest possible control of both decay and the natural ripening process.

Both decay and the ripening process can be largely controlled by refrigeration at 35° F (Pentzer, Wiant, and MacGillivray, 1940). Top-icing of full-slip, vine-ripened cantaloupes was first tried in 1944. It has now become a general practice in California and Arizona (Foote, 1946; Pentzer, *et al.*, 1947; Pentzer, *et al.*, 1948).

Ice blocks are cut into bits by machines and the crushed ice is blown directly over the loaded crates of melons in the refrigerator car.

Two uses for top-icing. The two uses are: (1) for cooling and refrigerating during transit, in which case transportation charges are made for the ice in addition to the load of melons; and (2), for cooling the load in pre-iced cars at the loading station.

Quantity of ice used. Sufficient ice should be used to maintain low temperatures in transit but not so much that the melons arrive at destination wet and covered with ice. Schedules for top-icing are based on melon temperatures (Foote, 1946) and respiration rates (Pentzer, *et al.*, 1948). Melting of 163 pounds of ice is required to lower the temperature of a car containing 312 crates of melons 1° F. The heat calculations and icing schedules for melons of different temperatures are given in table 3.

The shipper is permitted to place in

TABLE 3—Amount of Heat to Be Removed in Cooling 312 Crates of Cantaloupes from Temperatures of 95° to 65° F to a Final Temperature of 35° F*

Temperature of load	Removal of field heat to 35 degrees F		Vital heat in 48 hours		Total heat	Ice equivalent	
Degrees F	Degrees F	BTU	Degrees F	BTU	BTU	Pounds	300 lb blocks
95	60	1,408,380	60	296,000	1,704,380	11,800	39
90	55	1,291,020	60	296,000	1,587,020	11,000	37
85	50	1,173,650	55	199,490	1,373,140	9,500	32
80	45	1,056,290	50	102,960	1,159,250	8,000	27
75	40	938,920	50	102,960	1,041,880	7,200	24
70	35	821,550	45	88,550	910,100	6,300	21
65	30	704,190	45	88,550	792,740	5,500	18

* From: Pentzer, W. T., et al. Top-icing cantaloupes. U. S. Dept. Agr., Bur. Plant Ind., Soils, and Agr. Eng., Handling, Transportation, and Storage Off. Rpt. 185.

the body of the car at origin 5,000 or less pounds of ice, to accelerate cooling, providing the ice is consumed during the cooling operation, or is removed from the body of the car by the shipper prior to tender of shipment for transportation. If the ice is removed prior to tender of shipment for transportation, a minimum fee is assessed but no charge is made for transportation of top ice.

Cooling rate in car. The cooling rate of melons in a car is not so fast as might be imagined. Twenty to 24 hours may be required to reduce the temperature of the melons to 40° or 45° F. This period can be shortened by circulating the air in the car with built-in car fans or portable fans before the cars are moved. Forced air circulation cools the melons more rapidly than any other means.

SEED PRODUCTION . . . of high-quality, virus-free seed—an expensive undertaking but a necessary one—demands a very high degree of skill.

Need for reliable seed. The importance of reliable seed in cantaloupe production cannot be overemphasized. Poor germination, resulting in defective stands and a high percentage of off-type plants and fruits is often traced to the seed source. Mosaic virus may be introduced in carelessly handled seed. Considerable skill, experience, and expense are required to produce high-quality seed free from virus.

Hand-pollination sound practice. The different strains and varieties of cantaloupes cross readily among themselves. Cantaloupes also cross with Persian, Honey Ball, Honey Dew, and Casaba. They will not cross with cucumber, gherkin, watermelon, squash, or pumpkin. Bees are the most effective pollinators of melons. As these facts indicate, a seed plot to be effectively isolated should be located one-half mile or more from the nearest source of contamination. It is a sound practice to base the stock seed improvement program on a series of hand-pollinated inbred lines that have proved superior in comparative tests.

Roguing of fields. Seed fields are planted and cared for much as though the melons were to be harvested for ship-

ping. However, the seed fields should be rogued carefully for plants that are off-type, diseased, or that produce melons whose size, shape, or netting are not typical of the variety or strain. Rogued plants are removed as early as they can be recognized to reduce the amount of their pollen in the field.

Harvesting the crop. The melons should be fully ripe when harvested. Two hundred and fifty pounds of cleaned seed per acre are considered a good yield.

VARIETIES GROWN . . . must meet the public's choice in size, weight, flesh consistency and color, and percentage soluble solids content.

Consumer choice in melons. In making a choice of the variety or varieties to plant, growers and shippers must remember that the American public has been educated to demand cantaloupes that are well netted, medium sized (diameter 4 to 5 inches), broadly oval or round, and that weigh 2.5 to 3.5 pounds. The flesh should be thick and uniformly deep orange in color. It should contain not less than 11 to 12 per cent soluble solids. Except on a few local markets, extremely large or small melons, as well as green-fleshed and deeply sutured melons, are no longer in demand.

Several facts support the consumer in his choice of melons that meet the above requirements: 1) well-netted melons are likely to come from healthy vines and to be of good quality; 2) they suffer less damage from the harvesting and shipping routine; 3) medium-sized melons that are broadly oval or round make an attractive package, and are adapted either to family-size serving or to the restaurant and hotel trade; and 4) firm, thick, deep-orange-colored flesh, with soluble solids ranging above 11 per cent, usually indicates a vine-ripened melon of good flavor and edibility.

Selection of variety to plant. Other important factors govern selection of the proper variety to plant. Among them are location, soil conditions, and disease resistance. In general, preference should be given to varieties that are adapted to the particular locality in which the crop is to be grown. Varieties producing strong, vigorous vines with good foliage are less likely to produce poorly netted or sunburned melons.

All varieties of *Cucumis melo* are known as muskmelons. The species is divided into several botanical varieties. Botanically speaking, the term "cantaloupe" should be applied only to melons with a rough, warty surface, deep sutures, and hard rind. This type belongs to the botanical variety *cantaloupensis*, not grown in the United States. The green- and yellow-green-skinned, netted melons, classified as variety *reticulatus*, are called cantaloupes in this country.

Between 20 and 25 cantaloupe varieties are of economic importance in the United States. Of these, about six are grown in California. A description of the most important varieties follows.

CANTALOUPE VARIETIES

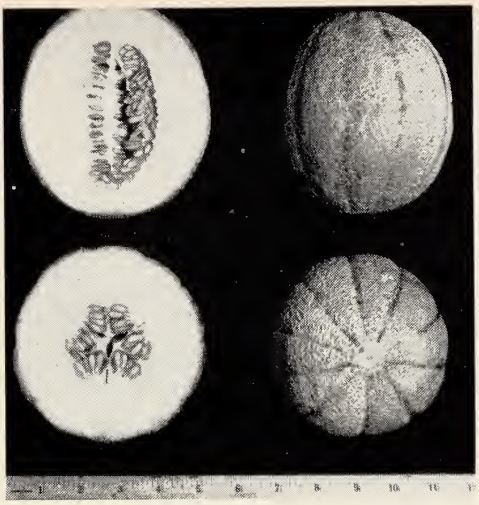
HALE'S BEST GROUP

Except on a few local markets, cantaloupe varieties of the Hale's Best Group dominate the commercial acreage in California (see table 4 for comparison of the Hale's Best Group of varieties). The original variety, Hale's Best, was introduced in 1924. Its development was the result of the alertness and enterprise of I. D. Hale of Brawley, California, who obtained the seed from a Japanese melon grower near Brawley. Although its origin is uncertain, it is thought to have resulted from a chance cross between the

TABLE 4—Comparison of the Important Economic Characteristics of the Leading Cantaloupe Varieties of the Hale's Best Group in California

Varieties	Vigor of vine	Resistance to powdery mildew	Days to maturity	Weight (lbs.)	Shape	Skin color	Net	Sutures	Cavity	Flesh color	Flavor	Soluble solids (per cent)
No. 45	good	resistant to race 1	95–110	2–3.5	broadly oval	yellow green	good	shallow	dry	salmon orange	excellent	12–14
No. 6	fair	resistant to races 1 and 2	95–110	2–3.5	round	yellow green	good	shallow	dry	light salmon orange	good	10–13
No. 5	good	resistant to races 1 and 2	100–115	2–3.5	round to broadly oval	yellow green	fair to poor	shallow to lacking	dry	salmon orange	excellent	12–14
V-1*	good	none	100–115	2–4	broadly oval	green	excellent	shallow to lacking	wet	salmon orange	good	11–13
S.R. 91*	good	none	95–110	2–4	broadly oval	yellow green	excellent	shallow to lacking	wet	salmon orange	good	11–13

* Although susceptible to powdery mildew this variety is resistant to injury by sulfur, which can be used to control mildew. Other common varieties are susceptible to injury by sulfur used as a fungicide.



Powdery Mildew Resistant Cantaloupe No. 45 has good net, thick flesh, and small, dry seed cavity.

salmon-tinted Pollock 10–25 and the variety Emerald Gem.

The original strains of Hale's Best variety were not very uniform; many rough, irregular, and large fruits were to be found. Selection by seedsmen has largely corrected these faults and several highly uniform strains are available, such as Hale's Best No. 36, No. 936, Jumbo Strain, and Seed Breeders. These varieties are susceptible to powdery mildew and sensitive to sulfur.

Powdery mildew resistant cantaloupe No. 45. This is a variety of the Hale's Best type that is resistant to race 1 of powdery mildew. It was developed by the United States Department of Agriculture and the California Agricultural Experiment Station, primarily for use in the Imperial Valley, where powdery mildew threatened to ruin the industry. A genetic factor for resistance to powdery mildew was found in muskmelons from India. These imported melons, having no economic value, had to be hybridized with commercial types. They were crossed with Hale's Best and several generations of backcrossing and inbreeding resulted in the release of Powdery Mildew Resistant Cantaloupe No. 45 in 1936.

This melon is an ideal shipping type. It can be harvested at full-slip without danger of becoming soft and over-ripe before reaching the consumer. It performs well wherever Hale's Best varieties are adapted and where the new (race 2) form of powdery mildew is not prevalent.

Description. Vines moderately vigorous under a wide range of environmental conditions, with abundant, large leaves; resistant to race 1 but not to race 2 of the powdery mildew organism; maturing in 95 to 110 days. Fruits broadly oval, with shallow sutures; diameter, 4 to 5 inches; weight, 2 to 3.5 pounds. Skin green, turning yellow green at harvest maturity; well netted. Flesh thick, salmon-orange, firm, sweet, with excellent flavor. Cavity small and dry.

A selection of No. 45 designated No. 450 is listed by some firms. For the most part, this selection is similar to No. 45, except that the melons are larger and the vines have greater vigor.

Powdery mildew resistant cantaloupe No. 6. Here is another variety of the Hale's Best group developed by the United States Department of Agriculture and the California Agricultural Experiment Station. No. 6 was produced in response to the need for a variety resistant to the new biological race (race 2) of the powdery mildew organism that first appeared in the Imperial Valley in 1938 and became epidemic in 1939 and thereafter.

By combining mildew resistance from several sources with the excellent shipping and consumer characteristics of No. 45, a new variety, No. 6, was synthesized and released in 1944. No. 6 is resistant to races 1 and 2 of the mildew and it is superior in external appearance to other varieties of this group. However, the flesh is not so deeply colored nor so high in soluble solids.

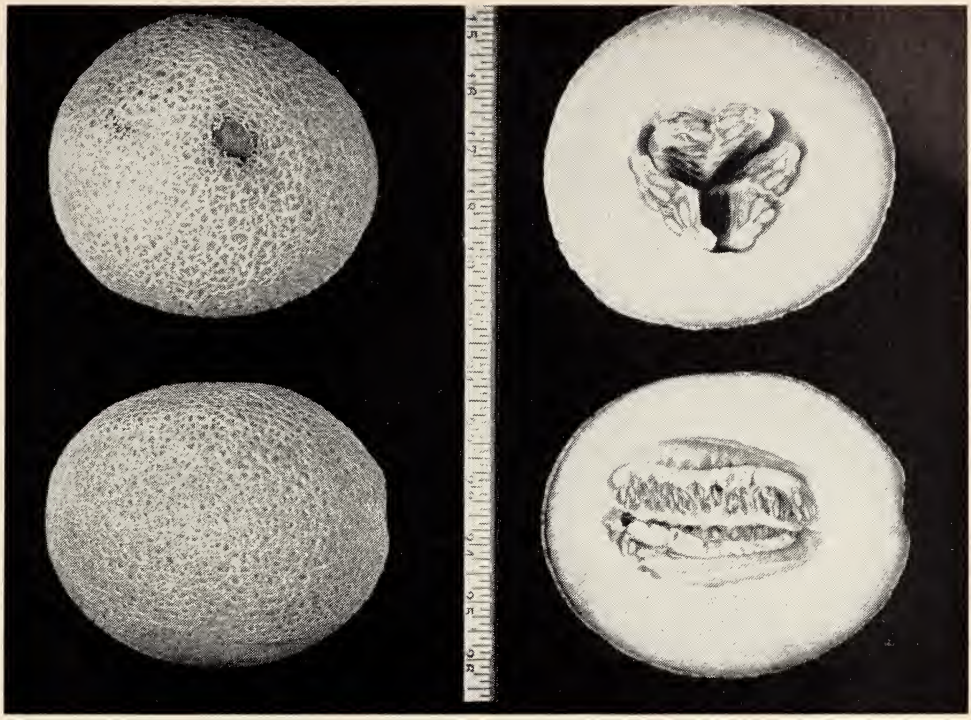
Description. Vines moderately vigorous during the spring in Imperial Valley; not so widely adapted as No. 45; resistant to races 1 and 2 of the powdery mildew

Powdery Mildew Resistant Cantaloupe No. 6 has a button-like protrusion at the blossom end.

organism; maturing in 95 to 110 days. Fruits spherical, with slight, shallow, open sutures; diameter, 4 to 5 inches; weight, 2 to 3.5 pounds. Skin green, turning yellow-green at harvest maturity; well netted. Flesh thick, light salmon-orange, firm, moderately sweet, with good flavor. Cavity small and dry.

Powdery mildew resistant cantaloupe No. 5. This variety was released in 1942 by the United States Department of Agriculture and the California Agricultural Experiment Station. It is a vigorous, prolific, high-quality variety derived from the same sources as No. 6. It is resistant to races 1 and 2 of powdery mildew. No. 5 has a narrow range of adaptation, performing best in warm, dry desert valleys. It is very susceptible to cantaloupe mosaic. The fruits, especially those on mosaic plants, may be small; or they may crack near the stem end or have a thin net. These defects have greatly restricted the usefulness of No. 5.

Description. Vines vigorous and prolific during the spring in Imperial Valley; not so widely adapted as No. 45; resistant to races 1 and 2 of the powdery mildew organism; maturing in 100 to 115 days. Fruits round to broadly oval, with slight-to-moderate, shallow open sutures; diameter, 4 to 5 inches; weight,



A thick, heavy net completely covers the sutures of Sulfur Resistant V-1.

2 to 3.5 pounds. Skin green, turning yellow green at harvest maturity; net well distributed but often thin. Flesh thick, salmon orange, moderately firm, sweet, with excellent flavor. Cavity small and dry.

Sulfur Resistant V-1.* This is a Hale's Best type developed by the Ferry Morse Seed Company from original material obtained from Dr. J. B. Norton of the Agricultural Commissioner's Office, El Centro, California. The original plant was evidently a chance hybrid of a pink-meat Honey Ball type with an unknown parent. From this material a number of lines that were resistant to sulfur injury were obtained. In 1938, crosses were made between these sulfur-resistant lines and Powdery Mildew Resistant Cantaloupe No. 45. After several generations of selection, Sulfur Resistant V-1 was released in 1941. V-1 is used mainly in the Imperial Valley or wherever there is danger of damage from powdery mildew. Since plants of this variety are resistant to sulfur injury, powdery mildew can be controlled by regular applications of dusting sulfur.

Description. Vines vigorous under a moderate range of environmental conditions, with abundant, large leaves; susceptible to powdery mildew but resistant to sulfur injury; maturing in 100 to 115 days. Fruits broadly oval, with slight-to-moderate, shallow sutures; diameter, 4 to 5 inches; weight, 2 to 4 pounds; skin green at harvest maturity; well netted. Flesh thick, salmon orange, moderately firm, sweet, with good flavor. Cavity small and inclined to be wet.

SR-91. Recently the Ferry Morse Seed Company released a new variety, SR-91, selected from the same source as V-1. SR-91 appears to be similar to V-1, except that vines are more prolific, melons mature somewhat earlier, and skin turns yellow green at harvest maturity.

* Information secured from the Ferry Morse Seed Company through the courtesy of W. N. Nixon and Frank G. Cuthbertson.

WINTER MELON VARIETIES

The so-called winter melons belong to the botanical variety *inodorus* of *Cucumis melo*. For the most part, these are late-maturing varieties with firm, thick flesh and good storage qualities. The important ones are described below.

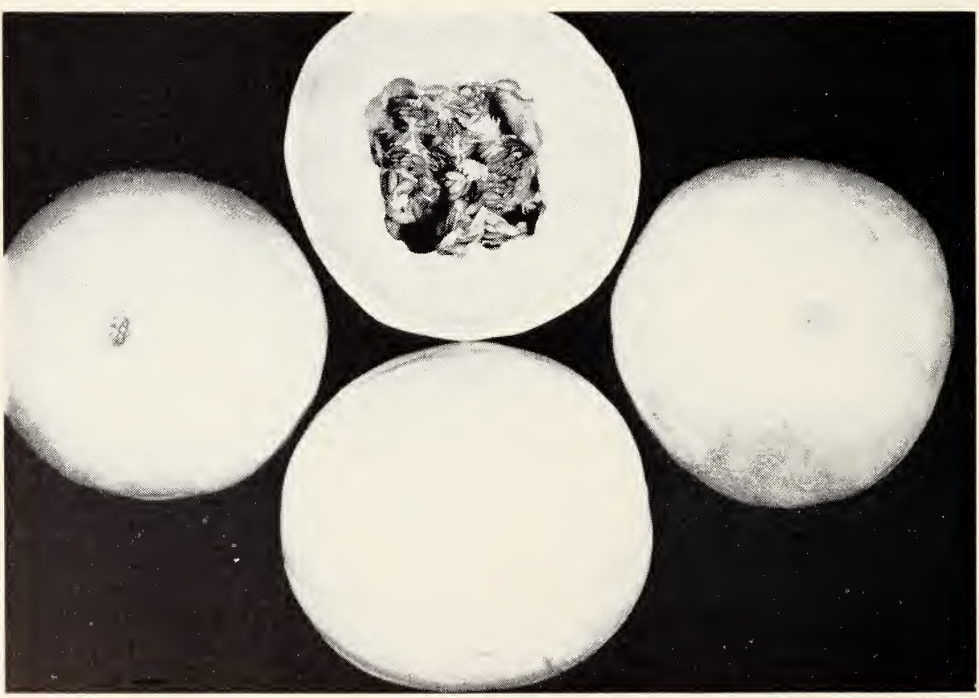
Honey Dew variety. This is one of the most popular varieties of the winter melon group. It was grown in France for many years under the name White Antibes and was introduced into this country in 1895. It was reintroduced in 1912 and soon thereafter became a popular variety in the Southwest. It is widely grown in the Central Valley; and if not exposed to mosaic, does well in the Imperial and Palo Verde valleys.

Description. Vines large and vigorous, prolific, and widely adapted; very susceptible to powdery mildew but resistant to sulfur injury; maturing in 110 to 125 days. Fruits round to broadly oval, without sutures; 6 to 8 inches in diameter, weighing 5 to 7 pounds. Fruits remain attached to the stem at harvest maturity. Skin ivory white or greenish white turning creamy white with pale yellow streaks or blotches at harvest maturity; smooth, with no net or rarely with small patches of net. Flesh moderately thick, green, firm but juicy, very sweet, with a mild, distinctive flavor. Cavity large, inclined to be wet.

Honey Ball group. There are two distinct varietal types of Honey Ball, namely green fleshed and pink meat. The original variety has green flesh.

Description. It is comparatively small, 5 inches in diameter, globular in shape, and has white skin without sutures. It is smooth or very sparsely netted, green fleshed, and sweet. It is very prolific. There are several varieties of the pink-meat Honey Ball, for example, Weaver Special, Globo de Oro, and Melogold. They are similar in most respects. Melogold is widely used for long-distance shipment and for local markets.

Melogold. This pink-meat Honey Ball was developed by the Rocky Ford Seed Breeders Association.



Fruits of Honey Dew are smooth, with greenish-white flesh and a large seed cavity.

Absence of netting and wrinkled appearance are characteristics of Golden Beauty Casaba. (Courtesy Lawrence Robinson and Sons.)

Description. Vines vigorous, very prolific, and widely adapted. It is very susceptible to powdery mildew, but resistant to sulfur injury; matures in 90 to 105 days. Fruits globular, without sutures; diameter, 5 to 6 inches; weight, 3 to 5 pounds. Fruits separate from the stem at harvest maturity, and can be picked on the slip. Skin white, turning cream to pale tan at harvest maturity; net well distributed but fine and thin. Flesh thick, bright pink orange, moderately firm, very sweet, with a mild, distinctive flavor. Cavity small, moderately dry.

Casaba group. This applies to certain varieties of the winter-melon group that are unusually large, with flesh of a distinct texture and flavor. They are harvested by cutting the stem when the melons are reasonably mature and held in storage until the blossom end becomes soft. As a rule, the flesh is less sweet than that of either Honey Ball or Honey Dew. Two varieties, Golden Beauty and Crenshaw, are of importance in California.

Golden Beauty casaba. This was one of the first varieties of Casaba introduced into this country and it has remained popular for both home garden and local market use.

Description. Vines large and vigorous, coarse, with large, deeply lobed leaves; intolerant of excessively high temperatures during harvest season; very susceptible to powdery mildew; matures in 110 to 125 days. Fruits globular but with pointed stem end; without sutures, but wrinkled, with longitudinal corrugations; diameter, 6 to 8 inches; weight, 4 to 7 pounds. Fruits remain attached to stem at maturity. Skin green, turning golden yellow during the ripening period, without net; soft; fruit easily bruised. Flesh thick, white, moderately firm but juicy, very sweet; of distinctive casaba flavor. Cavity moderately large, inclined to be wet.

Crenshaw. This variety is a relatively recent introduction (1939?). Its origin is obscure, but it has become very popular during the past decade as a local market melon in the Central Valley. The fruits can be shipped with careful handling. Growers usually obtain only one good harvest, because the remaining fruits sunburn quickly after the vines are disturbed.

Description. Vines similar to those of Golden Beauty; susceptible to powdery mildew; maturing in 110 to 125 days. Fruits pear shaped, without sutures,

Crenshaw is smooth, or only slightly netted, with wrinkled stem end. (Courtesy Lawrence Robinson and Sons.)

smooth; diameter, 6 to 8 inches; weight, 5 to 8 pounds. Fruits remain attached to the stem at maturity. Skin dark green, turning pale yellow-tan at maturity; with or without thin net; thin and soft; fruits easily bruised. Flesh thick, light salmon orange, very sweet, with a delicate casaba flavor. Cavity moderately large, moderately dry.

The Persian group includes at least two varieties, but only the variety commonly known as Persian is important in California.

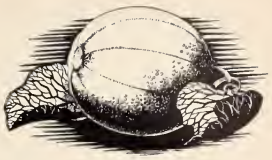
The Persian variety is supposed to have been introduced into the United States by Armenians. In California it has become a very popular local market melon and is also shipped to the fancy melon trade. It is grown chiefly in the Central Valley. In the warmer, drier climate of the Imperial Valley, it does not grow so well and rarely attains acceptable quality. Persian variety melons are harvested when they soften slightly at the blossom end.

Description. Vines of the Persian variety are stout, large and vigorous, with large leaves; intolerant of excessively high temperatures during the harvest season; very susceptible to powdery mildew; maturing in 105 to 120 days. Fruits globular, without sutures; diameter, 7 to 10 inches; weight, 6 to 8 pounds. Fruits separate from the stem at full maturity, but soon become over-ripe. Skin dark green; net abundant, well distributed but fine and thin. Flesh thick, bright orange, sweet, with a distinctive flavor. Cavity moderately large, dry.

Several small-fruited strains of the Persian have been introduced (see below). Typical melons are 4 to 5 inches in diameter; weight, 5 to 6 pounds; and have very fine net and green skin color. The flesh is thick and of good quality. The seed cavity is small. In other respects, the small-fruited strains correspond to the original type.

Persian, small strain, is uniformly globular in shape with fine net over entire fruit. (Courtesy Associated Seed Growers, Inc.)

DISEASES . . . include seedling and leaf diseases, root rot, vascular wilts, fruit rots, and virus diseases, such as muskmelon mosaic.



SEEDLING DISEASES

Young plants may fail to emerge or the stems may rot at the soil surface soon after emergence. Seedlings attacked after emergence fall over, wilt, and die. Such seedling rots and damping-off are caused by fungi that inhabit the soil (*Pythium* and *Rhizoctonia*). In cold, excessively wet soils they may cause severe losses resulting in poor stands of plants. Such losses can be prevented by treating the seeds with fungicidal dusts (Spergon 0.3 pound to 100 pounds of seed or Arasan 0.125 pound to 100 pounds of seed), by planting when temperatures are favorable for early emergence and vigorous growth, by planting the seeds at shallow depth, and by avoiding excessive soil moisture, especially at the soil surface.

ROOT ROT DISEASES

The roots of older plants may be attacked by several soil-inhabiting fungi, such as *Fusarium*, *Macrophomina*, *Phytophthora*, *Pythium*, *Rhizoctonia*, *Sclerotinia*, and *Sclerotium*. Attacked roots are killed and the aerial portions of the plants may be chlorotic (pale green or yellow), stunted, and nonthrifty, or they may wilt and die. Some of these fungi also attack the lower parts of the stems. *Macrophomina phaseoli* (Maub.) Ashby produces an appressed black growth on the roots and lower stem and causes the disease known as charcoal rot. Similarly, *Sclerotinia sclerotiorum* (Lib.) DBy. produces a white cottony growth and causes the disease called cottony rot.

Because these fungi live in the soil and attack host plants through the roots, they cannot be controlled with sprays and dusts. The root rots are generally more severe in heavy, cold, wet soils than in light, warm, well-aerated and well-drained soils. Root rot damage can be reduced by planting in light soils, by avoiding excessive irrigation, and by providing good drainage. Soils that have held previously infected crops should not be used for future crops.

VASCULAR WILTS

Plants of all ages may be attacked by fungi that grow in the water-conducting vessels (xylem or wood) of the vascular system in the roots, stems, and leaves. These diseases are usually observed in mature plants. If the stems of such plants are cut, dark-brown, discolored streaks of tissue can be observed. Attacked plants may be nonthrifty and chlorotic, or branches may suddenly wilt and die. The entire plant is often killed. These diseases are not important in California.

Bacterial wilt. This is caused by a bacterium, *Erwinia tracheiphila* (E.F. Sm.) Holland, that is carried from one plant to another by cucumber beetles. The bacteria are introduced into the veins in the leaf and invade the vascular system of the stem through the petiole. Bacterial masses ooze from the discolored vascular tissues in cut petioles or stems. This disease is limited in its host range to cucurbits and is seldom found in California.

Fusarium wilt. This disease is caused by *Fusarium oxysporum* Schlecht. f. *melonis* (Leach and Currence) Snyder and Hansen, a soil-inhabiting fungus that invades the plant through the roots. This disease cannot be controlled with sprays and dusts. It is controlled in the eastern United States by growing *Fusarium*-wilt-resistant varieties and by growing other varieties in soils that are free from the parasite. Fusarium wilt is not known to occur in California and resistant varieties are not needed.

Verticillium wilt. This is caused by a different soil-inhabiting fungus, *Verticillium albo-atrum* Reinke and Berth. This parasite also attacks the plant through the root system and cannot be controlled with sprays and dusts. It has a wide host range, including several vegetables, small fruits, tree fruits, and ornamentals. No *Verticillium*-wilt-resistant varieties of muskmelons are available. *Fusarium*-wilt-resistant varieties are susceptible to *Verticillium* wilt. *Verticillium* wilt is not a serious disease on muskmelons in California, but it has caused minor losses in the San Joaquin Valley, in the inner coastal valleys, and in the southern coastal plain. At present, this disease can be controlled only by planting muskmelons in soils free from *Verticillium*.

LEAF DISEASES

Several fungi attack the leaves of muskmelons. Some of these fungi cause chlorotic (pale or yellow) or necrotic (dead) spots on the leaves while others produce a visible growth on the surface of the leaves. Some of these fungi attack the stems as well as the leaves, but they are more readily observed on the latter.

Powdery mildew. This disease is caused by *Erysiphe cichoracearum* DC., a fungus that grows on the surfaces of the leaves and stems, sending minute feeding organs (*haustoria*) into the host tissues. As the name indicates, this disease can be recognized by the powdery white growth on the stems and both surfaces of the leaves. Leaves and stems that are infected may remain alive for indefinite periods or they may die and become brown and brittle. Severely attacked plants become weak and nonthrifty and produce few or no melons. The melons may be small or malformed or they may be normal in size or shape. Large melons often have poor net and poor flavor, and may be sunburned. These defects result from poor foliage.

Powdery mildew was the most important muskmelon disease in California for several years. It can now be controlled in cantaloupes by growing Powdery Mildew Resistant Cantaloupe No. 5 or No. 6. Number 45 can be grown successfully where race 2 of the powdery mildew organism does not occur.

Powdery mildew has spotted this cantaloupe leaf.

This disease can be controlled with sulfur dusts in Honey Dew and Honey Ball, and in the V-1 and SR-91 varieties of cantaloupes. However, even these varieties may be injured by sulfur during extremely hot weather. Powdery Mildew Resistant Cantaloupes No. 5, No. 6, and No. 45 should not be dusted with sulfur.

Powdery mildew can be controlled with some success in sulfur-sensitive, mildew-susceptible varieties of muskmelons with an application of 0.3 per cent (wt) liquid lime sulfur followed two weeks later by an application of 1.5 per cent yellow cuprous oxide (Middleton and Yarwood, 1946). A suitable wetting agent must be used with these spray materials and they must be applied in a manner to cover the stems and both surfaces of the leaves.

Downy mildew of muskmelons. This is caused by *Pseudoperonospora cubensis* (Berk. and Curt.) Rostoew., a fungus that invades the leaves. Infected spots turn yellow and later become dark brown or black. A blue-gray growth of the fungus occurs on only the lower sur-

face of the leaf at the infected spots during moist weather. Infected leaves die and become brown and dry. Defoliation usually begins at the base of the plant and progresses upward. The fruits on infected plants may fail to mature. Mature fruits are poor in quality and may be small or sunburned or may lack net.

This disease occurs in the southern coastal areas but not in the important interior-valley melon districts. It should not be confused with powdery mildew, which occurs in both regions. Downy mildew is controlled with 3–3–50 bordeaux spray, copper lime dusts (20 pounds monohydrate copper sulfate to 80 pounds hydrated lime, ground to pass a 200-mesh screen), tribasic copper sulfate dust (5 per cent Cu), or Dithane Z-78 (6 per cent) dust.

Target spot. This disease, caused by *Alternaria cucumerina* (Ell. and Ev.) J. A. Elliot, occurs in the inland valleys but is of little importance there. It occurs more often in the inner coastal valleys and on the southern coastal plain, where it causes moderate damage. Following rains, it may become severe. It can be controlled with 0.3 per cent liquid lime sulfur (Baume 32°) or 1.5 per cent yellow cuprous oxide.

Other leaf diseases. The warm, dry interior valleys are nearly free from several leaf diseases that are important in other parts of California.

Anthracnose and angular leaf spot are two of these diseases. *Anthracnose* is caused by *Colletotrichum lagenarium* (Pass.) Ell. and Halst., and angular leaf spot is caused by *Pseudomonas lachrymans* (E. F. Sm. and Bryan) Carsner. These diseases are not known to occur in the important melon-producing districts in these valleys.

FRUIT ROTS

A number of the fungi already discussed cause spots or rots in muskmelon fruits. Those that do not attack the fruits directly cause fruit defects through starvation and exposure. Other fungi attack only the fruits. These are primarily storage diseases that occur during the shipping and marketing of muskmelons. The losses from such diseases have been greatly reduced during recent years by clean handling in the packing sheds and rapid cooling of the melons in refrigerator cars. Refrigeration at 32° to 34° F reduces losses from fungus rots, but cold temperature breakdown may occur in Honey Dew following prolonged storage at these temperatures.

Fruit rots also cause some losses in the field. Excessive irrigation, poor drainage, and high relative humidity are the principal predisposing factors for infection. Good drainage and careful irrigation, especially during the harvest season, and prompt harvesting are recommended control measures.

VIRUS DISEASES

Plants of all ages may show definite disease symptoms without rotting of the tissues or discoloration of the vascular system. Virus diseases are included in this category. They are caused by submicroscopic entities that exist and multiply within the cells of the plant. The virus disrupts the normal activities of the host but usually does not kill it. It causes chlorosis, stunting, and distortion of the plant and reduces yield.

Muskmelon mosaic. This disease has caused severe losses in the important melon-producing interior valleys during recent years (Middleton, Swift, Kendrick, Dickson, Anderson, Bohn, and Whitaker, 1949). It can be caused by several different viruses. These viruses differ in their host ranges but they cause similar symptoms in muskmelons. They are considered together here.

The most commonly observed symptoms are mottling (mosaic), stunting, and distortion of leaves. Mottled leaves have dark-green and light-green or yellow areas of irregular form. The leaves are

often irregular in shape and portions of veins may be killed. The vine tips are often stunted and yellowish. Under certain conditions, stem growth may continue while that of leaves does not. This produces the appearance of rat-tail, commonly observed in mosaic plants in Imperial Valley (see photograph below).

Less readily observed symptoms include the abortion of flowers of all ages. Flowers that appear normal to casual observation often have aborted anthers and scant pollen. Fruits that are set may be normal in appearance or they may be mottled, small, or misshapen. Fruits that are not affected directly by the virus may be low in quality or sunburned or they may have poorly developed net. These indirect effects result from the lack of sufficient foliage to supply food and to cover the fruits. Losses are slight if the plants are not infected until they approach harvest maturity, but severe losses may result if the plants are infected when young.

No satisfactory measures have been developed to control muskmelon mosaic. All muskmelon varieties are susceptible but most cantaloupe varieties are affected less severely than are Honey Dew and Honey Ball varieties. One or more of the viruses may be seed-borne. Such viruses can be controlled in the absence of other sources of infection by using seed that is free from virus or by careful roguing at the thinning stage. Care must be used in thinning because the virus can be transmitted from one plant to another by the worker's hands.

The virus is usually transmitted from melons and from weed or other crop hosts to muskmelons by aphids. Attempts to arrest spread of the virus by controlling the aphids have not been successful (see page 37). Muskmelons should not be grown near squash plantings, and the areas bordering muskmelon fields should be kept free from weeds. The losses from mosaic can be held to a minimum by

Cantaloupe mosaic mottles and distorts the leaves, causing rat-tail shoots, such as the one at the right, and pale shoot tips with excessive numbers of flower buds.

using cultural practices that maintain vigorous growth.

Curly top of muskmelon. The virus that causes curly top of beets also causes curly top of muskmelons. The young leaves of diseased plants are stunted and curled, but may be normal in color; the older leaves are often yellow. The stems are shorter than normal, so that the plants are stunted and bushy. Infected plants usually fail to produce fruits and under some conditions the plants are killed. The virus is transmitted from beets to muskmelons by the beet leafhopper. Muskmelons should not be planted near sugar beet plantings in regions where this virus is known to occur.

OTHER PLANT ABNORMALITIES

Muskmelon plants may be stunted or their leaves may have chlorotic (pale) or necrotic (dead) spots or margins in the absence of mold growths on the plant or mosaic patterns on the leaves. Such abnormalities are caused by drought, frost, heat, wind, nutrient deficiencies, or salt excesses in the soil.

These diseases have not been studied intensively and will not be discussed in detail. Their frequent occurrence in the Imperial Valley and elsewhere in California indicates that they should be given more attention than they have received in the past.

INSECTS AND OTHER PESTS . . . include those attacking the germinating seeds of muskmelon plants and those attacking roots or leaves.

This section was prepared by W. H. Lange, L. D. Anderson, and W. W. Middlekauff, of the Departments of Entomology, at Davis, Riverside, and Berkeley, respectively.

Cantaloupes and other melons are often damaged by a number of pests. These may attack the germinating seed or the plants at any time during growth. Attacks are often sporadic and seasonal, and control measures may not always be necessary. Those pests primarily attacking the underground sections of the plants will be discussed first, then pests damaging the plants aboveground.

ROOT PESTS

Wireworms. These long, shiny brown worms often attack the germinating seeds and seedlings during the fall, spring, or early summer. The most destructive species in the interior valleys is *Limonius canus* Lec.

An economical control is seed treatment using 1⅓ ounces of 75 per cent lindane to 100 pounds of seed. This can be applied as a dry powder or by means of a slurry treater and, until further information is available, it should be used at recommended rates in combination with a fungicide, such as tetramethyl thiuramdisulfide (Arasan), 2,3-dichloro-1,4-napthoquinone (Phygon), or other commonly used fungicides. Seed should be treated within several weeks of planting and not stored for extended periods.

A fumigant, EDB (ethylene dibromide) is effective in the control of wireworms when used as a preplant treatment at the rate of 2 gallons of actual chemical per acre. The fumigant is applied by special applicator. Usually 10 to 14 days are allowed to pass before seeding. Soil treatments with DDT, chlordane, aldrin, or other chemicals should be applied only after consultation with qualified agricultural authorities.

Seed-corn maggot. Occasionally during cool weather and high soil-moisture content the maggots of *Hylemya cilicrura* (Rond.) attack germinating

seeds, causing disfigurement of the plants or death of the seedlings. Seed treatment as mentioned under wireworms may prove adequate in most instances.

Nematodes. The garden or root-knot nematode often attacks melons, particularly in light, sandy soils. These invisible worms form galls in knots on the small roots and cause stunting or even death of the plants. The development of resistant varieties is a possible solution, but resistant varieties are not now available. Soil can be fumigated with 2 to 4 gallons of actual EDB (ethylene dibromide) or 25 to 40 gallons of a dichloropropane-dichloropropene mixture (D-D) for temporary control where rotations or other cultural control measures are not possible.

Cutworms. Young plants are often damaged or killed by cutworms. These caterpillars usually hide in the soil under debris or under clods during the day. At night they come out to feed, cutting off the plants at or just below the crown level. Several different species are involved. In localized infestations, where only a few hills are damaged, the grower can merely replant. If, however, a considerable area is damaged, the use of insecticides is advisable.

Control by insecticides has not always given consistent results. The material most likely to be satisfactory is DDT. This can be applied as a 5 per cent dust at the rate of 30 to 40 pounds per acre, or as a spray at the rate of 2 to 3 quarts of 25 per cent emulsifiable concentrate per acre, in an amount of water that will vary from 6 to 100 gallons depending on the type of equipment. Airplane or ground sprayers or dusters may be used to apply these DDT mixtures. Excessive amounts of DDT should not be used on melons or other cucurbits, especially when the plants are small, as it may temporarily retard plant growth.

Several bait formulas are used against cutworms. One that has been fairly successful is as follows: bran, 80 pounds; 25 per cent DDT emulsion concentrate, 1⅜ gallons; lubricating oil S.A.E. 10–20 W, 1½ gallons. Another commonly used formula is: bran, 85 pounds; Paris green or white arsenic, 4 pounds; lubricating oil S.A.E. 10–20 W, 1½ gallons.

In making the DDT bait the DDT concentrate and the oil are mixed first, and then this solution is blended with the bran. In making the arsenical baits the dry poison is thoroughly mixed with the bran and the oil is then blended in. The oil in these bait mixtures keeps them moist and attractive for a longer period than was true of water-moistened baits formerly recommended. Bait is applied broadcast at the rate of 20 to 40 pounds per acre, concentrated on the hills. It is most effective applied in the evening.

LEAF PESTS

Melon aphid. The melon aphid, *Aphis gossypii* Glov., is one of the most damaging of melon pests. These small, green plant lice are first seen on young plants near the tips of runners or in growing points. They cluster in large numbers on the undersides of growing leaves, distorting and curling the leaves. Several other aphids occasionally cause similar injury. The end result of attack is severe stunting or even death of the plant.

Spot chemical treatments are of great value to control early isolated infestations in an attempt to prevent later general infestations.

Chemical treatments suggested for melon aphid control are: 1 to 2 per cent parathion dust at 25 to 35 pounds per acre; 1 per cent TEPP dust at 35 to 40 pounds per acre (do not apply if dew is present on the plants) or a nicotine dust containing 4 per cent nicotine (as alkaloid). Applications must be thorough and should be applied in calm weather. Nicotine is more effective in warm weather, and the free nicotine type in cool weather.

Parathion and TEPP often cause a substantial reduction in the predaceous

enemies of aphids, and for this reason the grower should determine in a general way the numbers of ladybird beetles or syrphid fly larvae present and time his applications accordingly. Nicotine is not so potent in reducing predator populations, but it will be more effective when these natural enemies are present to reduce numbers of surviving aphids.

Sprays containing nicotine sulfate (Black Leaf 40, ¾ to 1 pint per 100 gallons of water with a small amount of spreader) are satisfactory and may be preferable in home gardens.

In all cases, timely applications are necessary. Once aphids have curled the leaves, control is very difficult.

Green peach aphid. In desert areas, muskmelon mosaic is transmitted chiefly by the green peach aphid, *Myzus persicae* (Sulzer). This aphid moves into melon fields in large numbers from surrounding vegetation, especially sugar beets, and carries the mosaic virus as it moves from one plant to another. The green peach aphid does not breed on melon plants. To date, insecticide applications have proved ineffective in checking the spread of this virus.

Cucumber beetles. These common green and black beetles, some spotted and some striped, are familiar to every grower. The two common species are *Diabrotica 11-punctata* Mann. and *Acalymma trivittata* (Mann.). They fly readily and migrate into cultivated areas from alfalfa and uncultivated lands. They prefer the tender, succulent portions of the plants, chew the leaves full of holes, and scar the runners and young fruits.

For early season application, where leafhoppers are not a problem, use a 50 per cent cryolite dust at 30 pounds per acre. A 3 to 5 per cent DDT dust applied at 25 to 35 pounds per acre by ground or airplane equipment gives good control. DDT sprays, using 2 pounds of a 50 per cent wettable powder per acre or the equivalent as an emulsifiable concentrate, are effective.

In dusts, sulfur can usually be used safely as a diluent on Persian, Honey Dew, and Crenshaw, but it should *not* be used on most varieties of cantaloupes. DDT may cause a build-up of aphids, but it should be included because of its excellent control of cucumber beetles and leafhoppers. Application of DDT, however, should be kept to a minimum to avoid stunting the plants.

Leafhoppers. These tiny, green, jumping insects often damage melons, especially late in the season. The most common species is the melon leafhopper, *Empoasca abrupta* De Long. The leafhopper has sucking mouthparts and causes severe white stippling and yellowing of the leaves, green-spotting of the fruit, and premature leaf-drop. DDT as recommended for cucumber beetles gives good control. A 3 per cent DDT dust is often recommended in preference to the 5 per cent DDT as it does not favor a severe increase in the aphid populations.

Leafminer. The serpentine, white tunnels of a leafminer, *Liriomyza subpusilla* (Frost), often are seen in leaves of various melon varieties. This fly attacks alfalfa, which is often a source of infestation, and various other cultivated crops and weeds. Occasionally it causes a drying of the leaves, resulting in sunburning of fruit and reduction in yield and melon quality. Natural enemies usually keep it under control. Experimental information indicates that aldrin and dieldrin (not yet registered for use on melons) are very effective in controlling the leafminer. Until these chemicals are available, a suggested control is the use of chlordane as a 5 per cent dust, using two or three applications at 15-day intervals, applied when the plants are about half grown. Single applications are ineffective. Dieldrin is effective at rates of ½ to 1 pound per acre as sprays and as a 2.5 per cent dust; two to three applications should be made at 15-day intervals.

Flea beetles. These small, jumping insects, usually bronze or metallic blue

black, feed on the leaves in the same manner as cucumber beetles. DDT dusts, as recommended for cucumber beetles, keep these pests under control.

Thrips. Thrips are very tiny active insects that scar the surface of the leaves and flowers and feed on the exuded sap. This injury causes a breakdown of the tissue and gives the leaves a silvered appearance. Severely affected leaves drop prematurely. DDT as recommended for cucumber beetles gives satisfactory control. Repeated applications may be necessary.

Red spider mites. Leaves attacked by these mites become blotched with pale-yellow and reddish-brown spots. Eventually the leaves take on a pale, sickly appearance and gradually dry and drop. Examination of the leaves with a lens will reveal numerous minute pale-green, red, or brown, eight-legged mites, often mottled. Minute spherical eggs and silk webbing may also be present. The webbing is often filled with cast skins, dust, and other debris. The Pacific mite, *Tetranychus pacificus* McGregor, and the two-spotted mite, *Tetranychus bimaculatus* Harvey, are the most destructive species.

Several recently developed acaricides show promise in the control of these pests. At the time of writing, dusts containing 2 to 3 per cent aramite, 10 per cent ovotran, and 10 per cent sulphenone show great promise when used at 30 to 40 pounds per acre. Excessive amounts of these new acaricides may cause a slight yellowing of the leaf margins under certain climatic conditions. One and 2 per cent parathion dusts applied at similar rates give a good initial kill of these mites, but the residual action is poor and frequent applications may be necessary.

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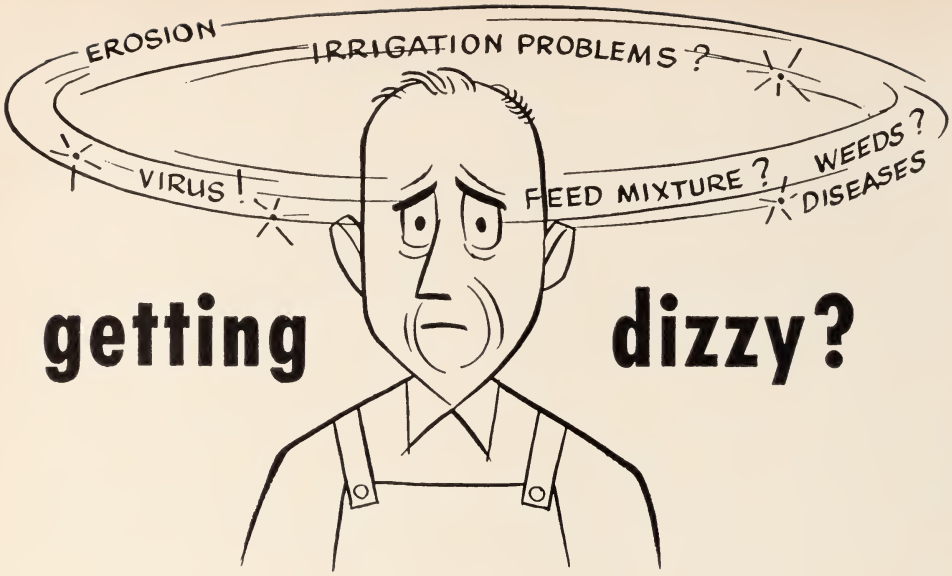

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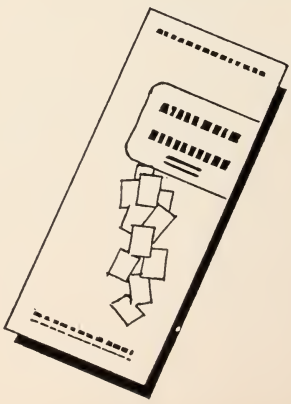

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